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PROJECT COMPLETION REPORT

CHINA

**LUBUGE HYDROELECTRIC PROJECT
(LOAN 2382-CHA)**

NOVEMBER 22, 1993

MICROGRAPHICS

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**Industry and Energy Operations Division
China and Mongolia Department
East Asia and Pacific Regional Office**

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CURRENCY EQUIVALENTS

Currency Name - Renminbi
Currency Unit - Yuan (Y)
At Appraisal (1982) \$1.0 = Y 2.00

Exchange Rates During Project Years

	<u>Yearly Average</u>	<u>End of Year</u>
1984	2.0615	2.8027
1985	2.9513	3.2095
1986	3.4626	3.7314
1987	3.7314	3.7314
1988	3.7314	3.7314
1989	3.7317	4.7339
1990	4.8596	5.2352
1991	5.3603	5.4478

FISCAL YEAR

January 1 - December 31

WEIGHTS AND MEASURES

1 cubic meter (m ³)	=	35.3 cubic feet (ft ³)
1 metric ton	=	1,000 kilograms (kg)
1 kilometer (km)	=	0.6215 miles (mi)
1 kilovolt (kV)	=	1,000 volts (V)
1 megavolt-ampere (MVA)	=	1,000 kilovolt-amperes (kVA)
1 megawatt (MW)	=	1,000 kilowatts (kW)
1 gigawatt hour (GWh)	=	1 million kilowatt hours (kWh)

ABBREVIATIONS AND ACRONYMS

ADAB	-	Australian Development Assistance Bureau
AGN	-	Advisory Group of Norway
FCB	-	Fourteenth Construction Bureau
GOC	-	Government of the People's Republic of China
HWL	-	High Water Level
KHIDI	-	Kunming Hydroelectric Investigation and Design Institute
LPCMB	-	Lubuge Project Construction Management Bureau
SBC	-	Special Board of Consultants
SMEC	-	Snowy Mountains Engineering Corporation
TCC	-	Technical Cooperation Credit
YPEPB	-	Yunnan Provincial Electric Power Bureau

THE WORLD BANK
Washington, D.C. 20433
U.S.A.

Office of Director-General
Operations Evaluation

November 22, 1993

MEMORANDUM TO THE EXECUTIVE DIRECTORS AND THE PRESIDENT

SUBJECT: Project Completion Report on China
Lubuge Hydroelectric Project (Loan 2382-CHA)

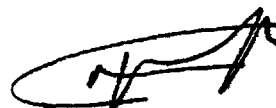
Attached is the "Project Completion Report on China - Lubuge Hydroelectric Project (Loan 2382-CHA)" prepared by the East Asia and Pacific Region. Part II was prepared by the Borrower.

This was the first Bank loan to the power sector in China. The US\$145.4 million loan increased the generation capacity for the Yunnan power grid. All but US\$4 million were disbursed. Suppliers' credits remained unused. Cofinancing was obtained in the form of grants from Norway, Australia and Canada (US\$10.8 million, US\$4.8 million and US\$160,000, respectively).

All project components were implemented including a fourth generating unit added to the original scope. The loan introduced into the Chinese power sector - with substantial benefits - not only modern technology, but international competitive bidding for civil works, and the use of a Special Board of Consultants. Generally, coordination between the Borrower, contractors and consultants was good. However financial covenants were not met.

The PCR gives a thorough account of project preparation and implementation which was mostly uneventful. Overall, the project is rated as satisfactory, and its institutional impact as substantial. Its sustainability is uncertain as it depends upon the consolidation of tariff reforms by the government of the Yunnan Province.

The project may be audited together with other power projects in China.



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LUBUGE HYDROELECTRIC PROJECT (LOAN 2382-CHA)

PROJECT COMPLETION REPORT

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LUBUGE HYDROELECTRIC PROJECT (LOAN 2382-CHA)

PROJECT COMPLETION REPORT

PREFACE

This is the Project Completion Report (PCR) for the first power project in China, for which Loan 2382-CHA in the amount of \$145.4 million was approved on February 21, 1984. The loan was closed on June 30, 1992, against the original closing date of June 30, 1990, two years later than originally expected. A total of \$4.0 million was canceled on January 5, 1991. Total disbursements under this loan were \$141.4 million. Cofinancing for this project included a grant in the amount of NKr 88 million (equivalent to about \$10.8 million) from the Norwegian Government, a grant in the amount of \$A 6.8 million (\$4.8 million equivalent) from the Australian Development Assistance Bureau (ADAB), and a grant in the amount of Can\$200,000 grant (\$160,000 equivalent) from the Canadian International Development Agency (CIDA). No export/supplier's credits were used for the procurement of turbines, generators, and auxiliaries, as originally planned.

The Preface, Evaluation Summary, Part I, and Part III of this PCR were prepared by the Industry and Energy Operations Division, Country Department II (China and Mongolia), of the East Asia and Pacific Regional Office. Part II was prepared by the Lubuge Project Construction Management Bureau (LPCMB).

Preparation of this PCR was based on the Staff Appraisal Report (SAR); the Loan and Project Agreements; Bank supervision reports; correspondence between the Bank, LPCMB, and the Yunnan Provincial Power Bureau (YPEPB); internal Bank Group memoranda; and a mission to China in February 1993. Valuable assistance and cooperation were provided to the mission by the staff of the Beneficiary (YPEPB) and LPCMB in the preparation of system information and financial statements, and in updating statistical data, particularly those included in Part III.

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LUBUGE HYDROELECTRIC PROJECT (LOAN 2382-CHA)

PROJECT COMPLETION REPORT

EVALUATION SUMMARY

Project Objectives

1. The Government's strategy for resolving issues and achieving its objectives in the power subsector is to (a) introduce modern methods and enhance technology transfer in the power subsector; (b) set energy prices gradually to ensure the financial viability of energy producers and encourage the rational use of electric energy; (c) increase autonomy in investment and operation matters; (d) accelerate the pace of hydroelectric development, construction of large coal-fired thermal power plants, and extension of extra high-voltage transmission networks to transmit power to load centers and to interconnect major regional power systems; and (e) replace obsolete and small thermal power generating plants with larger and more efficient units, and convert expensive oil-fired generating units to coal-firing to the extent practicable. The above objectives are being implemented step by step through the lending operations in China. The Lubuge Hydroelectric Project is the first power project in China, the objectives of which are detailed in Part I, para. 3.1.

Implementation Experience

2. All the main physical components of the project were successfully completed. The first 150 MW unit (Unit No. 4) was commissioned in accordance with the schedule set in the SAR. The second and third units (Unit Nos. 3 and 2) were put in operation about two-and-a-half and five months, respectively, behind the appraisal estimate, but were ahead of the state's revised target dates.

3. The actual cost of the project, when expressed in US dollars at prevailing exchange rates, was about 8 percent lower than the appraisal estimate in spite of the addition of the fourth unit that was not in the original project scope (para. 6.2), appreciation of foreign currencies with respect to US dollars, and higher local inflation than originally forecasted (Part I, para. 7.2).

4. Total loan amount disbursed was \$141,500,000. The closing date of the loan was extended twice from the original date of June 30, 1990 to June 30, 1992, because part of the civil works was delayed and more time was needed for procurement of additional equipment, spare parts, testing instruments, and engineering services (Part I, para. 7.5).

5. The covenants contained in the Loan Agreement and Project Agreement were met with the exception of the revenue covenant and the debt service covenant (Sections 4.63 and 4.04 of the Project Agreement). The current tariff has not been adequately adjusted to enable YPEPB to cover all the operating costs and debt services (Part I, para. 8.1).

Results

6. All the main objectives of the project were met; Lubuge Hydro station is now playing a key role in the Yunnan power system. In 1992, the four 150 MW units already generated 2,394 GWh of energy and 627 MW of valuable peaking capacity, about 21.2 percent and 25.7 percent, respectively, of the system total, even though that was a very dry hydro year.

7. Outstanding results were achieved in the construction of the project, including, for the first time in China, use of the Special Board of Consultants (SBC) and foreign consultants in the optimization of project design, introduction of modern technology, use of international competitive bidding for civil works, application of effective construction management, successful cofinancing arrangements, and excellent coordination among LPCMB, consultants, contractors, and manufacturers. The positive impact of the Lubuge project on the construction industry in China far exceeded expectations.

8. The training program of the project was carried out successfully. Altogether, 76 lectures attended by 1,100 participants were given by the consultants in Kunming and at the job site on engineering and design, modern construction technology, construction management, operation and maintenance of specific construction equipment, contract management and claim management. Thirty-six groups received a total of 292 staff-months of overseas training under different sources of financing in the areas of engineering and design, construction supervision and management, modern construction technology, plant operation and maintenance, and financial management.

9. The ex-post internal economic rate of return (IERR) for the project was 10.2 percent, compared with the appraisal estimate of 12.0 percent (Part I, para. 7.6).

Sustainability

10. The benefits that YPEPB is reaping from the project are definitely sustainable, since (a) YPEPB has demonstrated its ability to operate and maintain its facilities efficiently; (b) the demand for electricity in Yunnan is growing rapidly and has already absorbed fully the output of the plant within four years; and (c) GOC has consistently shown its commitment to institutional improvement.

Findings and Lessons Learned

11. Major findings are as follows:

- (a) The project was well prepared and implemented. It has been operating satisfactorily since June 1991 with the exception of the fourth unit (Part I, paras. 6.2 and 7.1).
- (b) The left bank landslide about 1.5 km upstream of the dam has been stabilized. Drilling investigation and instrumentation observation confirmed that the slide was a shallow movement in the talus area.
- (c) The local government reforested both banks with the Reservoir Maintenance Fund, financed out of the revenues from power sales (Part I, para. 7.7).
- (d) The resettlement program was carried out satisfactorily (Part I, para. 7.7).
- (e) The dam and other important structures have been monitored and inspected periodically, as required.
- (f) YPEPB's financial performance suffered from a lack of timely and adequate increases in electricity tariff to meet YPEPB's revenue and debt service covenants specified in the Project Agreement (Part I, para. 8.1).

12. Major lessons learned from the project are summarized below:

- (a) Since this was the first power project in China, more time should have been allowed in the project cycle. About 13 months elapsed between project appraisal and loan negotiations to solve the issues of using SBC and foreign consultants, cofinancing arrangements, agreement on using ICB for civil works, and prequalification of bidders.
- (b) Because of the delays mentioned in para. 12(a), the construction schedule and the loan closing date were unreasonably tight. The project completion date should have been set six months after the commissioning of the last unit (June 30, 1990), and the loan closing date should have been set about one year after the project completion date (June 30, 1991).
- (c) Contract packaging of procurement was very important for implementing the project. The success of the first ICB contract for civil works in China stemmed from the selection of the headrace tunnel as the first test case. Tunnel construction normally requires less labor compared with other civil works and is carried out continuously cycle by cycle. A foreign contractor would therefore be able to manage it more easily in a market environment prevailing at that time.
- (d) Introduction of the first Special Board of Consultants (SBC) to China was a success. It was highly justified by the abundant engineering experience, correct judgments, and recommendations of the board members. Not only did it save on project costs but it also shortened the construction period so that some of the key target dates on the critical path could be met. SBC's contribution would have

been even greater if it had been involved in the early stages of project preparation during the review of project layout and selection of dam type.

- (e) Thanks to the grant funds provided by the Australian, Norwegian, and Canadian governments, convincing Chinese authorities to use foreign consultants for the first time in China was possible. The contribution of these consultants to the project was highly appreciated by all the related institutions because of their valuable services in engineering and design, construction management and supervision, and technology transfer and training. Foreign consultants have been used since then for nearly all the Bank-financed projects. The Technical Cooperation Credit's (TCC's) role in providing funds for project preparation remains very important.

- (f) The turbines and generators of the Lubuge project were supplied by the Lubuge Consortium consisting of Kvaener of Norway and Siemens of Germany. They subcontracted part of the work to a local electrical and machinery works with the first unit supplied mainly by Kvaener and Siemens, gradually reducing the share of foreign partners' inputs unit by unit. While this was a logical arrangement for transferring technology and promoting domestic industries, it created the problems of quality control and integrity of responsibility. The first unit has been in operation since the end of 1988, generating 3,267 GWh (62.2 percent capacity factor) of energy without any problems. In addition to the time lost from a problem with the stator during erection, the stator coil of the fourth unit caught fire twice during initial operation in 1991 and 1992.

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LUBUGE HYDROELECTRIC PROJECT (LOAN 2382-CHA)

PROJECT COMPLETION REPORT

PART I: PROJECT REVIEW FROM BANK'S PERSPECTIVE

1. Project Identity

Name	: Lubuge Hydroelectric Project
Loan Number	: 2382-CHA
RVP Unit	: East Asia and Pacific Region
Country	: China
Sector	: Energy
Subsector	: Power

2. Background

2.1 The Yunnan provincial power grid had a total installed capacity of 1,271 MW by the end of 1982, consisting of 754 MW of hydro (59.3 percent) and 517 MW of thermal (40.7 percent). Peak demand was 916.5 MW and energy generation, 5,360 GWh. The system was expected to grow at an average rate of 7-8 percent over the 1983-91 period. The system had little reserve margin. To meet the expected load growth, the system had to be expanded. YPEPB's strategy was to develop indigenous resources, such as the mine-mouth coal-fired thermal station at Xiaolongtan (6 x 100 MW) and the renewable hydro resources, the Lubuge Hydroelectric Project, as implemented. Both projects formed parts of the least-cost sequence of development. The project was approved by the Government of the People's Republic of China (GOC) in June 1981.

3. Project Objectives

3.1 The principal objectives of the project were (a) to provide generating capacity and energy to the Yunnan power grid; (b) to introduce modern technology in the construction of dams, tunnels, and underground powerhouses; (c) to introduce ICB for procurement of civil works and associated technical assistance; (d) to address financial and auditing issues; (e) to introduce financial forecasting; (f) to promote cofinancing with bilateral and export credit sources; and (g) to provide staff training.

4. Project Description

4.1 The Lubuge Hydroelectric Project comprised the following:

- (a) construction of a rockfill dam about 100 m high, a spillway system, an intake structure, a 9.4 km headrace tunnel, a surge tank, two penstock shafts with steel lining, an underground powerhouse, a tailrace tunnel, with a switchyard and provision of equipment therefore;
- (b) provision and installation of three generating units of 150 MW each, with provision ultimately for a fourth unit;
- (c) provision and construction of two parallel 220 kV transmission lines (single-circuit) of about 184 km each from Lubuge to Kunming and one 220 kV transmission line (single-circuit) of about 129 km from Lubuge to Qujing with associated substations;
- (d) consultant services, a Special Board of Consultants (SBC) and construction management and supervision; and
- (e) a training program.

5. Project Design and Organization

5.1 **Field Investigations.** Feasibility study, engineering, and detailed design of the project were carried out by the Kunming Hydroelectric Investigation and Design Institute (KHIDI). The Snowy Mountains Engineering Corporation (SMEC), financed under a grant by the Australian Development Assistance Bureau (ADAB), provided services to Phase I-Phase III for project preparation in reviewing the project design, preparation of bidding documents, bid evaluation, and training by 16 experts from December 1982 to July 1984, totaling 57 staff-months. SMEC also provided services from December 1984 to March 1989 for Phase IV in construction management and supervision for the headwork complex and the water conductor system, technology transfer, contract management, and erection supervision of the electrical and mechanical equipment and training. Forty experts contributed 310 staff-months to the services. The Advisory Group of Norway (AGN), financed under a Norwegian grant, provided services for training, construction management, and supervision of the underground powerhouse and tailrace tunnel construction. Thirty-six experts contributed a total of 160 staff-months.

5.2 Entrusted by YPEPB, the Lubuge Project Construction Management Bureau (LPCMB) was established in April 1984 to carry out site management of the project and supervise the works constructed by the Fourteenth Construction Bureau (FCB) and the foreign contractors/suppliers with the assistance of SMEC and AGN. This was the first construction entity organized in China to supervise the project construction as the "engineer" on behalf of the owner, YPEPB, for the tunnel contract, and to represent the Ministry as the owner for the FCB contract.

6. Project Implementation

6.1 The project was completed on December 31, 1991, about two years behind the appraisal schedule and one year behind the revised target date set by the state. The main reasons are:

- (a) addition of the fourth unit, which was not originally part of the project;
- (b) delay of part of the civil works, particularly the left bank spillway tunnel; and
- (c) procurement of additional equipment.

6.2 The first unit was put into commercial operation on December 27, 1988, as specified in the appraisal estimate, and three months in advance of the revised target date. The second and third units were commissioned on September 19, 1989 and May 21, 1990, respectively, about 2.5 months and 5 months behind the appraisal estimate, but ahead of the revised target dates. The fourth unit (not part of the original project) was added later on by the Ministry in order to generate more secondary energy during the wet season and to provide reserve margin to the system. This unit was commissioned on June 14, 1991, in spite of the delays caused by the poor quality of the laminated steel of the stator; it took nine months to repair.

6.3 The 220 kV transmission line from Lubuge to Kunming I, including the substation, was put into operation in November 1988, about one month ahead of the appraisal estimate. The remaining lines were about six months (220 kV Lubuge-Kunming II), 25 months (220 kV Lubuge-Qujing), and 21 months (110 kV Lubuge-Xinyi) behind the appraisal estimate. They were purposely rescheduled in accordance with the system's need to minimize early investment.

6.4 **Training.** The training program under the Lubuge project can be divided into two main categories: domestic training and overseas training. Domestic training was conducted mainly by two groups of consultants: SMEC and AGN. These groups gave lectures on engineering and design, modern construction technology, construction management, operation and maintenance of specific construction equipment, contract management, claims management, computer application, and English, both at the job site and in Kunming. Altogether, 76 lectures were given to a total of 1,100 participants. The overseas training provided by the consulting groups, contractor, and equipment suppliers totaled 292 staff-months in 36 groups in the area of engineering and design, construction management, modern construction technology, financial management and accounting, and plant operation and maintenance (see Annex 1 for details).

6.5 Through using foreign consultants and contractors and by introducing modern technology in construction management, the Lubuge project elevated the design, construction, and management capabilities in China and built up a team that can adapt itself to modern construction for large hydroelectric projects. As the experience and personnel

of this project has spread to other projects, hydropower development of the whole country has been enhanced.

7. Project Results

7.1 The project fully achieved its main objectives through successful completion of 4 x 150 MW generating units and associated 220 kV and 110 kV transmission lines and substations. The Lubuge station became the master plant of the entire Yunnan power grid, providing 25.7 percent of peaking capacity (627 MW) and 21.2 percent of energy generation (2,393 GWh) in 1992 (Part III). It also provides spinning reserve capacity to the system for frequency and voltage control and enables optimal utilization of other hydro reservoirs. The dam and other structures are being inspected periodically, as specified. The project is functioning satisfactorily, with the exception of the generator of the fourth unit, because its stator caught fire on December 2, 1991, and again on December 7, 1992 (because the stator coil end connection burned out). Since all the outages occurred in the dry season, there was no major impact on the plant generating output.

7.2 The estimated cost of the project at appraisal (excluding IDC and other financial charges) was Y 820 million in local cost and \$205 million in foreign cost, equivalent to a total of Y 1,230 million when expressed in local currency and \$615 million when expressed in US dollars at the then prevailing rate of exchange. The actual cost was Y 1,354 million in local cost and \$157 million in foreign cost, equivalent to a total of Y 1,945 million when expressed in local currency and \$567 million when expressed in US dollars (see Part III for details). Compared with the appraisal estimate, it has a cost underrun of about 8 percent when expressed in US dollars and a cost overrun of about 58 percent when expressed in yuan. These variations were mainly caused by the devaluation of the local currency from an exchange rate of Y 2 to \$1 at the time of appraisal to Y 5.45 to \$1 by the end of 1991, the project completion date. The average of the exchange rate over the construction period was Y 3.43 to \$1.

7.3 Project costs, expressed in yuan terms, increased for three reasons:

- (a) The additional cost of about Y 78 million for the fourth unit was not originally expected during appraisal.
- (b) Currencies used under the main contracts, such as Japanese yen and German mark, appreciated against the US dollar.
- (c) Local rates of inflation used in the calculation of price contingencies were on the low side (only 3 percent a year), compared with the actual inflation during project implementation (about 7-8 percent a year).

7.4 The specific cost of the project was about \$945 per kW installed. This indicates favorable results achieved in constructing this cost-effective power project when compared with similar hydropower projects in other countries.

7.5 A summary comparison of the estimated disbursements at appraisal with the actual disbursements is given in Part III. The original loan closing date was June 30, 1990. The actual closing date was June 30, 1992, after two extensions due to the delay of the civil works and the procurement at the late stage of the project on gas-insulated switchgear for integrating Yunnan power grid into one network (\$11.5 million), spare parts (\$2.3 million), testing instruments (\$0.7 million), and engineering services for the fourth unit and training (\$1.0 million). Based on the revised cost estimate in late 1991, \$4.0 million was canceled from the loan on January 5, 1991. The last disbursement of \$1,027,875.19 was made on July 1, 1992. Total loan amount disbursed was \$141,500,000.

7.6 The economic reevaluation of the project was carried out as follows:

- (a) actual cost data were used for the project and associated transmission;
- (b) operational and maintenance costs were assumed to be 1 percent of the capital costs, both for generation and transmission;
- (c) distribution and other costs were calculated based on YPEPB's financial analysis reaching Y 0.008 per kWh in 1992 and thereafter;
- (d) the prevailing average tariffs were used as the minimum proxy of the economic value of electricity;
- (e) a surplus benefit of Y 0.01 per kWh was added for surcharges collected by the local governments for power development; and
- (f) all costs and revenues were converted to 1989 constant prices by applying price indexes for local and foreign costs.

On this basis, the ex-post internal economic rate of return (IERR) for the project was 10.2 percent, compared with the appraisal estimate of 12.0 percent (Annex 2). The lower return was due primarily to the insufficient tariff increases.

7.7 **Resettlement and Environmental Aspect.** The population affected by the Lubuge project was successfully resettled. Out of 818 people in Yunnan province, 418 were engaged in farming in nearby areas above the reservoir level, 300 were resettled in a newly established village near Louping, and 100 were assigned to reservoir maintenance and other development activities by the local governments. Of 569 people in Guizhou province, most of them were engaged in farming in nearby higher areas, but some people were settled in Moponshan county. The affected people were adequately compensated. LPCMB prepared a detailed report on human resettlement in the project area that indicated that the living standard of the resettled people improved considerably over that of the preproject time. The people were provided with more living area (about 40 m² per capita), drinking water, electricity, and transportation and communication facilities. Also, new modern schools and health centers were built. Those engaged in farming were provided

more cultivated land (about 1.1 mu per capita). The water conservancy and irrigation facilities built during the project have already enhanced land productivity. YPEPB decided to set aside Y 1 for every 1,000 kWh generated by the Lubuge plant to establish a Reservoir Maintenance Fund, 80 percent of which was used by the local governments for reforestation, fishery, and agricultural development activities; 20 percent was retained by the power station for reservoir cleaning, maintenance works, etc. Local institutions have been established to deal with such activities.

7.8 Instead of the traditional method of resettlement through compensation only, a new approach was introduced at Lubuge with the cooperation of the local governments. The approach consisted of helping the resettled people to engage in sideline activities and combining the resettlement with the reservoir maintenance and development.

8. Financial Performance

8.1 Salient features of YPEPB's finances over the period of 1984-92 are summarized in Annex 3. YPEPB's actual financial performance was less than satisfactory and fell short of expectations. YPEPB was not able to comply with the revenue and debt service covenants [Section 4.03(a) and Section 4.04 of the Project Agreement] since 1988. YPEPB met only on average 51 percent of its principal and interest payments due from 1988 to 1992, and the debt service coverage ratios of YPEPB over the same period dropped below 1. As a result, substantial loan repayments to the People's Construction Bank of China (PCBC) in the past five years were deferred. YPEPB's finances were adversely affected by (a) the higher-than-expected local inflation rates (3 percent a year projected in the SAR versus 7-8 percent a year actual and over 10 percent a year for construction work) during the implementation period; (b) the devaluation of the local currency from an exchange rate of Y 2 to \$1 at appraisal to Y 5.45 to \$1 by the end of 1992; (c) the escalated debt service requirements due to the above two factors; and (d) the slow pace in tariff adjustment. Although its tariff level increased (8 percent a year) faster than appraisal forecast (3 percent a year), increases in operating cost (19 percent a year) outpaced the tariff increase by a significant margin. Fuel costs, mainly coal prices, went above even the general price increase. During appraisal, the price for standard coal was projected to increase by 3.5 percent in 1985 and 3 percent in 1986 and onwards. The actual price for coal increased by 12 percent a year during 1984-92. The moderate growth in electricity sales, which was close to SAR projections, only partially offset the negative impact on YPEPB's profitability. The rate of return on net fixed assets based on historical value before income tax declined to its record low level of 3.7 percent in 1988 and only recovered to 5.6 percent by 1992. Consequently, YPEPB has experienced great difficulties in meeting its financial obligations.

8.2 During the period under review, YPEPB's average tariff would have to be increased at a pace of 12 percent a year to comply with the Bank's financial covenants. However, regulatory body or well-defined mechanism enforcing tariff adjustments so far does not exist in China. In the case of YPEPB, the provincial price bureau decides on its annual tariff adjustment. The provincial government was overly concerned about price stability in the province and approved only a fraction of the proposed price increases in the

past few years. The general guideline of "new plant, new price" set by the central government has not been fully implemented in Yunnan. In fact, for most industries, the share of electricity cost is less than 3-5 percent of their total operating expenses. An accelerated adjustment of the electricity tariff for most industrial users would not have a significant impact on inflation. Since YPEPB is no longer able to rely on government's budgetary support and given the huge investment plan along Lancangjiang in future years, it is imperative that the pace and magnitude of tariff adjustment be increased. It is encouraging to note that the provincial government has already approved and implemented an increase of about 31 percent over 1992 in the average tariff for 1993.

8.3 The Bank's objective to promote prudent financial management at the entity level was achieved through YPEPB's compliance with the financial covenant that required YPEPB to prepare long-term financial planning, focus on its trend of production costs as well as its future investment program and related financing arrangements, and annual review of such plans with the Bank.

9. Project Sustainability

9.1 The growth of YPEPB electricity sales has been averaging about 10.5 percent a year over the past three years (1990-92). Sales of electricity are expected to continue to grow at an average of about 10 percent per year into the 1990s. The output of the Lubuge project has been fully absorbed by the system within four years of operation. The completion of the Xiaolungton thermal power project (6 x 100 MW) by the end of 1992 and the commissioning of the first unit of the Manwan hydroelectric project expected in 1993 will timely provide the system with needed capacity and electricity, even with surplus to export to Guangdong province through the Tianshengqiao transmission network. These projects formed not only part of the least-cost development program for YPEPB, but also met the objectives of GOC's energy policy by making optimal utilization of China's indigenous energy resources of coal and hydro potential.

9.2 YPEPB has adequately trained its staff to operate the facilities efficiently under the project. More than 80 percent of the plant staff are high school graduates or above. They are a well-educated operating force who have been trained adequately, both domestically and overseas.

10. Bank Performance

10.1 The performance of the Bank from project preparation through project completion was satisfactory. The Bank maintained good relations with YPEPB, LPCMB, KHIDI, and the consultants throughout execution of the project.

10.2 In addition to the timely completion of its first major hydropower project in China, the Bank made the following noteworthy achievements:

- (a) **Cofinancing Arrangements.** The Bank successfully obtained support from the governments of Australia, Norway, and Canada to finance the consulting

services and SBC for the Lubuge project. Without this support, convincing Chinese entities to use foreign consultants would have been difficult.

- (b) **ICB for Civil Works.** The Bank obtained the agreement from GOC to experiment with ICB for civil works for the first time in China. Through the joint efforts of Bank engineers and procurement advisors, the details of supplying labors and materials, which were fair to foreign and local bidders, along with criteria for prequalifications, were worked out during the preparation of bidding documents. The result of the ICB procurement, as reflected in the quality of final product and contractor performance, was outstanding.
- (c) **Packaging of Works for ICB and Division of Responsibility between Consulting Groups.** To effectively demonstrate the importance of construction management in a civil works contract, the headrace water conveyance system was wisely selected as the package for ICB. SMEC was assigned responsibility for the headwork complex, which included the main dam and the headrace water conveyance system, and AGN was given responsibility for the underground powerhouse and tailrace tunnel component, to best utilize the comparative strengths of respective consulting groups.
- (d) **Training.** A successful training program was carried out by the consulting groups, contractors and equipment suppliers for the staff of KHIDI, YPEPB, and LPCMB in engineering and design, construction management and technologies, and plant operation and maintenance.
- (e) **Assistance in Procurement.** The Bank discussed in detail with KHIDI and LPCMB the ICB procedures, prequalification criteria for civil works bidders and provided assistance for the finalization of bidding documents.
- (f) **Assistance Provided in YPEPB's Financial Statements and Projections.** The Bank introduced the basic concepts of financial management and Western accounting to YPEPB's financial staff. The assistance provided by the Bank in this regard will facilitate YPEPB to move into the new accounting system effective on July 1, 1993.

11. Borrower Performance

11.1 **KHIDI.** KHIDI has been responsible for the field investigation, engineering and feasibility study of the project since 1976. The preliminary design report was completed in June 1991. With the assistance of foreign consultants, KHIDI was fully involved in the detailed engineering and design of the project, preparation of bidding documents for civil works and electrical and mechanical equipment, and construction supervision of the project. KHIDI did an excellent job in design (para. 13.1 on design optimization) and supervision, ensuring that construction was carried out as designed.

Through the learning process by working together with foreign consultants, KHIDI has developed itself into a well-established design institute. KHIDI is now involved in the engineering and design of the Tianshengqiao High Dam Project financed by the Overseas Economic Cooperation Funds of Japan and the cascaded development of hydro projects on the Lancang river in Yunnan.

11.2 YPEPB. YPEPB entrusted LPCMB with full responsibility and power to deal with any matter related to the project. During the critical period of 1988, YPEPB sent several electrical engineers to participate in the erection and commissioning of the first unit. The Lubuge General Power Plant, the operational unit of YPEPB, cooperated well with LPCMB during the entire erection period and established itself through domestic and overseas training as a strong and experienced team for operating and maintaining the plant. With the exception of the financial setback for not being able to meet the revenue and debt service covenants, YPEPB was operated well and managed in a generally commendable manner (see Annex 4 for YPEPB's performance from 1984 to 1992). Its expansion program was carried out as originally planned to utilize effectively the indigenous coal reserves and hydro potential. Total system losses were kept to an acceptable level of 7 percent. Capacity factors of thermal and hydro plants both operated favorably at around 50 percent.

11.3 LPCMB. LPCMB was responsible for overall project management. It was well organized, staffed, and led by a group of experienced and capable engineers. It played an important role in coordinating, supporting, and managing the designer (KHIDI), the contractors (Taisei and FCB), and the consultants (SMEC and AGN). LPCMB paid high regards to the Bank's project management from appraisal to follow-up supervision and to the Bank's emphasis on technology transfer, institution building, and staff training. LPCMB is preparing a paper to summarize their findings and the lessons learned.

11.4 Taisei Corporation. Taisei Corporation of Japan was the contractor for the headrace water conveyance system. Notice to proceed was issued on July 1, 1984, about seven months behind schedule. Because of its excellent planning of construction equipment and field management, it set a world record in tunnel excavation and concrete lining for an 8.8 m diameter tunnel. Average monthly progress for excavation (by the full face method) was 231 m, with a maximum of 873.7 m. Average monthly progress for concrete lining was 187 m, with a maximum of 270 m. The contract was completed on August 13, 1988, about four months ahead of the contracted schedule.

11.5 Fourteenth Construction Bureau (FCB). FCB was the contractor for the headwork complex, underground powerhouse, and tailrace tunnel. Preparatory works were completed in 1982. Diversion tunnel excavation started in December 1982. River closure was made on November 15, 1985, as scheduled. Reservoir impounding was started on November 21, 1988, to create the conditions for operating the first unit by December 27, 1988. The dam embankment reached the designed crest elevation of 1,138 m in July 1989. The performance of the works can best be demonstrated by the following indicators:

	<u>Design Value</u>	<u>Actually Measured</u>
Core wall settlement of the maximum section (mm)		
Upon completion	2,700	1,651 (07/89)
2.5 years after completion	3,800	1,762 (02/92)
Total leakage through the dam (liter/sec)	281 (HWL 1130)	101 (12/88) (HWL 1110)
		87 (12/91) (HWL 1130)

Other displacement measurements for the high walls of the spillway and the underground powerhouse indicated that everything was normal.

11.6 With the management experience, construction equipment, and technology gained during the construction of the Lubuge project, FCB has become a well-known construction force in China for rockfill dams and underground works. After the successful completion of the Guangdong Pumped Storage Project (Stage I), FCB will continue to work for the Stage II extension (another 4 x 300 MW). The bureau was recently awarded the contract for the lower reservoir and underground powerhouse for the Tianhuangping Pumped Storage Project (a Bank loan approved on May 18, 1993).

12. Project Relationship

12.1 The Bank-Borrower relationship for the Lubuge project was not only one of mutual trust and cooperation, but also was highly complementary in all aspects of project implementation. Constraints and bottlenecks were removed efficiently and expeditiously without negative impacts on the Bank-Borrower relationship.

12.2 The Bank's relationship with GOC, other national agencies, and related institutions was also cordial. The Bank had no problem gaining access to the high-level government authorities to discuss policy and render professional advice.

13. Consulting Services

13.1 Valuable contributions were made by SBC, SMEC, and AGN, either individually or jointly, throughout the project implementation period. They not only introduced the modern hydropower technology to China, but also optimized the design to reduce project costs and expedite the construction schedule. Ten major contributions were proposed by the three consulting groups and applied by KHIDI. At least Y 46 million was saved, about 2.0 percent of the total project costs. The main contributions to cost savings are summarized as follows:

- (a) use of weathered materials for the dam core;

- (b) cancellation of the bottom grouting gallery and reduction of dam foundation grouting from 52,000 m to 28,000 m;
- (c) modification of diversion tunnel lining;
- (d) adoption of a high wall for the vertical spillway by using anchoring rods and wire mesh;
- (e) reduction of the thickness of the headrace tunnel lining and use of plain concrete for 70 percent of the tunnel;
- (f) reduction of the span of the powerhouse from 24 m to 18 m; and
- (g) use of bench-cut, prestressed, and grouted anchor rods as support for the crane girdle without concrete columns.

13.2 Some of the technologies have now been widely used in China. In addition, these consultants provided the Chinese staff with domestic and overseas training, as well as instructions in their day-to-day work together on construction management, contract management, quality control, cost control, and schedule control. With the experience and knowledge gained during the Lubuge project, they developed into a backbone construction group, a majority of whose staff are now working at the 3,300 MW Ertan Hydroelectric Project (Loan 3387-CHA).

14. Project Documentation and Data

14.1 The legal agreements for the Lubuge project were appropriate for achieving the project objectives and adequately reflected the Bank's interest in satisfactory execution of the projects. The Staff Appraisal Reports were comprehensive, well prepared, and useful for the Bank, YPEPB and LPCMB during the project implementation. LPCMB submitted quarterly progress reports, which served as a valuable tool for supervising and monitoring the project. YPEPB submitted annual financial statements, an annual audit report by independent auditors, and future investment programs, as covenanted in the Project Agreement.

15. Conclusions and Recommendations

15.1 The Lubuge project was well prepared and constructed. All the major objectives of the project have been met. In spite of some project delays and two extensions of the loan closing date, the project was highly successful.

15.2 GOC selected Lubuge as the first power project in China to utilize the Bank loan and to test its "open door" policy and the Bank's ICB procurement procedures for the headrace tunnel. The excellent performance of the Japanese contractor shocked the entire hydroelectric construction circle and the building industry. The Chinese realized that a

compact organization, modern construction technology, and effective field management are the key factors of success. Local competitive bidding has been widely used since then to replace the old system of assignment and negotiation. Attention has been paid all over China to learn the experience of Lubuge in project management—the so-called Lubuge Pounding.

15.3 Use of SBC and foreign consultants was well justified. They need to be involved at the early stage of project preparation. Starting with the Lubuge project, availability of TCC funds has greatly facilitated the establishment of a strong pipeline of projects for Bank financing.

15.4 Training also has played an important role in changing the overall concept about management, strengthening managers' decision-making capabilities, and improving their project management skills. However, financial management is still a weak link. Training in this respect lags behind and needs to be strengthened.

15.5 As further measures of economic and system reforms are being undertaken in China, YPEPB's future finances are subject to considerable uncertainties. With a view to promoting financial management, YPEPB should place increased emphasis on long-term financial planning and continue to update its rolling long-term financial plan from time to time to reflect significant changes in the parameters affecting its finances.

15.6 To improve YPEPB's financial position, the tariff must be adjusted at a faster pace so that it can meet all its financial obligations and generate sufficient cash to finance its expansion plan.

15.7 Efforts should be made to reduce the bed load into entering the reservoir by constructing debris dams upstream of reservoir and on the tributaries. Watershed management should also be enforced. Reservoir sedimentation will not only reduce the effective storage capacity, but will also produce erosion and maintenance problems for hydraulic structures, particularly the right bank sluice tunnel.

15.8 Monitoring of the left bank landslide area 1.5 km upstream of the dam should be continued, particularly during the first flushing operation of the reservoir, which is expected in 1993.

15.9 The power plant is short of certain spare parts and consumables. Measures should be taken so that they can be procured and shipped expeditiously.

15.10 After completion of the downstream Tianshengqiao high dam scheme, now under construction on the Nanpan river, sedimentation entering that reservoir would eventually silt up as far as the tailwater zone of the Lubuge plant. Appropriate measures should be taken in due time to minimize its effects on the normal operation of the Lubuge plant.

PART II: PROJECT REVIEW FROM BORROWER'S PERSPECTIVE

16. Adequacy and Accuracy of Factual Information in Part III 1/

16.1 The factual information of the project presented in the tables of Part III, prepared by the Borrower's related institutions including IPEPB, LPCMB and KHIDI, were reviewed and cross-checked thoroughly with the Bank's mission in February 1993. They are adequate and accurate.

17. Comments on the Analysis Contained in Part I

17.1 Most of the analyses made by the Bank are based on the factual information in the tables of Part III. The comments and analyses made by the Bank are comprehensive, fair, and objective.

17.2 The Bank's analysis of project implementation was compared primarily on the basis of the staff appraisal report (SAR). If compared with the State plan, the results are as follows:

	<u>State Plan</u>	<u>Actual</u>	<u>Comparison</u>
Project Completion Date	End 1990	End 1991	Delayed by one year due to late delivery of the 4th unit.
Project Cost (Y million)	1,661.07 (excluding transmission lines and substations)	1,587.54 (on the same basis)	A savings of about 4.5%

The project is therefore considered as reasonably on schedule (the fourth unit was not originally a part of the project) and within cost.

17.3 The impact of the project to the hydro construction and building industries in China was indeed great. This was detailed with lessons learned in a report entitled "Lubuge and Lubuge Impounding," prepared jointly in 1992 by LPCMD, the Xinhua News Agency, and the Editorial Office of "Water Power" of MOE and MNR. This project changed completely the local bidding process and the concept of construction management system in China.

17.4 The direct benefits of the project consisted of 627 MW of peaking capacity and 2,392 GWh of energy generation in 1992, representing 25.7 percent and 21.2 percent, respectively, of the system total. It becomes the master plant of the system for frequency

1/ Primarily based on a project completion report prepared by LPCMB (kept in the Project File).

control and voltage control and for optimized operation with other hydro reservoirs. Other indirect benefits include:

- (a) promoting development of the project area through a new approach of the resettlement program;
- (b) accelerating development of hydropower construction in China; and
- (c) training of staff.

18. Evaluation of Bank's Performance

18.1 From the experience gained under the Lubuge Project, we found that the Bank's Project Cycle procedures in handling its projects are scientific and effective (a detailed report summarizing our findings is being prepared by LPCMB). It played an important role in making possible the successful achievements of the project. Appreciation was due specifically to the Bank for providing assistance in cofinancing arrangements, transferring of modern technologies through the use of foreign consultants, introduction of ICB for civil works and equipment, institutional building in the areas of accounting, auditing and financial projection, and staff training.

18.2 The visits made by the Bank's supervision missions were timely and fruitful, particularly during the crucial periods of river diversion and commissioning of the first unit. Valuable assistance was provided in expediting the urgently needed construction equipment and in convincing the field supervisors of the equipment suppliers to bring about a better cooperation during erection. Assistance was also provided by mission members in procurement, effective utilization of the Ban loan, financial projection, tariff level calculation and repayment capability, etc.

18.3 However, the procedures of ICB for both civil works and equipment were too complicated and time-consuming. This accounted for the delays in the early stage of project implementation. More lead time should be provided for project preparation and the procurement procedures should be further simplified and improved.

19. Evaluation of Borrower's Own Performance

19.1 We concurred fully with the observations made by the Bank in Part I regarding the Borrower's performance. YPEPB, as the owner, provided full support to the project. LPCMB, as an agency responsible for the overall management of the project, played an effective and successful role in coordinating, supporting, and managing among the designer (KHIDI), the contractors (Taisei and FCB) and the consultants (SMEC and AGN). With the assistance of SBC and foreign consultants, KHIDI did an excellent job in optimizing the design of the project.

19.2 To express our appreciation to SMEC and AGN, LPCMB prepared the following two reports in 1989:

- (a) **Friendly Assistance and Successful Cooperation on Utilization of Australian Grant for Lubuge Project (1982-89); and**
- (b) **Friendship and Cooperation on Utilization of Norwegian Grant for Lubuge Project (1984-88).**

They summarized the successful utilization of the grant funds for project design, supervision and construction management, and staff training.

19.3 Lessons learned from the project are:

- (a) **The use of SBC and foreign consultants is highly justified. Their early involvement for project preparation should be sought through the utilization of the TCC fund.**
- (b) **LPCMB is the first of its kind established in China for the management of international contracts for civil works. While the same practice has been followed up for the Shuikou and Ertan Hydroelectric Projects, these organizations should be maintained on a relatively long-term basis and their staff should be utilized effectively from job to job, so that they can adapt themselves for increasing numbers of international contracts in the future.**
- (c) **The relation between LPCMB and KHIDI should be rectified to establish a better design management and construction supervision system.**
- (d) **Through its excellent performance of the Taisei Corporation for the water conveyance system, the importance of construction management was fully realized by the hydro construction industry in China. The construction management system is being renovated and local competitive bidding is now widely used in China.**
- (e) **To comply with the Bank's loan covenants, YPEPB decided, effective January 1993, to increase its average tariff level by Y 3.78/kWh to meet its debt service requirements.**

PART III: STATISTICAL INFORMATION

1. Related Bank Loans

Loan title	Purpose	Approval	Status
Ln 2493-CHA Second Power Project	To construct a 500 kV transmission line from Xuzhou to Shanghai and 5 associated substations totaling 3,500 MVA in capacity, to install tele-control and tele-communications equipment for load dispatching, and to provide training for 500 kV transmission lines and substations.	02/19/85	Completed in December 1988.
Ln 2706-CHA & Ln 2955-CHA Beilungang Thermal Power Projects I & II	To construct a coal-fired thermal power project with 2 units of 600 MW and 2 single circuits of 500 kV transmission lines and 2 substations, and to carry out a training program and a tariff study for East China power grid.	05/29/85 & 06/14/88	Commercial operation for No. 1 is expected in the first quarter of 1993. Closing date extended for one year to 06/30/93. No. 2 unit still under implementation. Closing date 06/30/95.
Ln 2707-CHA Yantan Hydro- electric Project	To construct a 110 m high concrete gravity dam, a spillway, a powerhouse, and a shiplift; to install 4 generating units of 275 MW each, 2 single circuits of 500 kV transmission lines and 3 associated substations; and to carry out a training program.	05/29/86	Implementation under way. Closing date 06/30/93 as scheduled.
Ln 2775-CHA & Ln 3515-CHA Shuikou Hydroelectric Projects I & II	To construct a 101 m high, concrete gravity dam, a spillway, a powerhouse and a navigation lock; to install 7 generating units of 200 MW each; to carry out a resettlement program in the reservoir, an action plan for tariff reform, and a training program for planning and financial management.	01/06/87 & 09/01/92	Implementation under way. Closing dates 06/30/93 & 12/31/96.
Ln 2852-CHA Wujing Ther- mal Power Project	To install 2 additional coal-fired units of 300 MW each and associated 220 kV transmission lines and substations; to provide on-line computer control and automatic load dispatching center; to carry out a masterplan study for the distribution network in Shanghai and a training program.	06/23/87	Two units commissioned in 1992. Closing date 06/30/93.
Ln 3387-CHA Ertan Hydro- electric Project	To construct a 240 m high arch dam with an underground powerhouse, to install 6 550 MW generating units and associated equipment; to carry out an environmental management program, studies of power pricing and reservoir operation, and a training program.	07/02/91	Implementation under way. Closing date 12/31/96.

1. Related Bank Loans (cont'd)

Loan title	Purpose	Approval	Status
Cr 2305 & Ln 3412-CHA Daguangba Multipurpose Project	To construct a 56 m high gravity dam and an underground powerhouse with 4 x 60 MW generating units; to erect a 36 km long double-circuit 220 kV transmission line and to build canals to irrigate 12,700 ha of land.	10/31/91	Implementation under way. Closing date 12/31/97.
Ln 3433-CHA Yanshi Ther- mal Power Project	To install 2 300 MW generating units and 5 220 kV transmission lines and associated substations; to carry out a tariff study, a tariff action plan, and a training program for upgrading the technical, financial and management skills for HPEPB staff.	01/14/92	Implementation under way. Closing date 12/31/97.
Ln 3462-CHA Zouxian Ther- mal Power Project	To install 2 additional 600 MW generating units; to construct 500 kV and 220 kV transmission lines and substations; and to carry out an air quality control study, a power tariff study, an action plan for tariff adjustment, and a training program for the technical, financial, and management staff of SPEPB.	04/12/92	Implementation under way. Closing date 06/30/99.

2. Project Timetable

Items	Date Planned	Date Revised	Actual Date
Identification/ preparation	09/81		09/81
Preappraisal	04/82	04/82	04/82
Appraisal	08/82	10/82	10/82
Loan Negotiations	03/83	03/83	12/09/83
Loan Approval	05/83	10/83	02/21/84
Loan Signature			03/12/84
Loan Effectiveness			06/12/84
Loan Closing	06/30/90	(i) 06/30/91 (ii) 06/30/92	06/30/92
Loan Completion			07/01/92

COMMENTS: About 13 months were needed between project appraisal and loan negotiations to resolve issues of using SBC and foreign consultants, cofinancing arrangements, agreement on using ICB for civil works, and prequalification of bidders.

3. Loan Disbursements

Cumulative Estimated and Actual Disbursements
(\$ million)

Bank Fiscal Year and Semester	Estimated cumulative	Actual cumulative <u>/a</u>	Actual as % of estimate
1984 I			
1984 II	14.5	0.3	2.1
1985 I	21.8	36.3	2.7
1985 II	5.0	12.4	13.8
1986 I	50.8	65.3	21.9
1986 II	42.0	43.1	64.3
1987 I	79.3	94.3	61.2
1987 II	69.5	76.7	78.7
1988 I	108.8	123.3	81.9
1988 II	97.0	75.3	78.7
1989 I	130.6	137.9	106.0
1989 II	109.9	81.2	79.7
1990 I	141.6	145.4	113.9
1990 II	119.1	80.4	81.9
1991 I		121.1	83.3
1991 II		127.8	87.9
1992 I		140.4	96.6
1992 II		141.4/ <u>b</u>	97.2

/a \$4,000,000 was canceled from the loan on 01/05/91.

/b Total disbursement under this loan was \$141,400,000.00. The last disbursement of \$1,027,875.19 was made on 07/01/92.

Comments: The loan closing date was extended twice due to delays in procurement of switching equipment, spare parts, testing instruments, additional engineering services, and training in order to further improve the performance of the Yunnan power system.

4. Project Implementation

Indicators	Appraisal estimate	Revised target set by state	Actual
(1) Project Completion Date	12/31/89	12/90	12/31/91
(2) Civil Works	06/30/89		08/91
(3) Generating Units:			
1st	12/31/88	03/31/89	12/27/88
2nd	06/30/89	11/30/89	09/19/89
3rd	12/31/89	08/31/90	05/21/90
4th		09/30/91	06/14/91
(4) Transmission Lines and Substations:			
220kV Lubuge-Kunming I	12/31/88		11/88
220kV Lubuge-Kunming II	12/31/88		06/89 <u>/a</u>
220kV Lubuge-Qujing	12/31/88		01/91 <u>/a</u>
110 kV Lubuge-Xinyi	12/31/88		09/90 <u>/a</u>
Kunming I substation (Dongqiao)	12/31/88		11/88 <u>/a</u>
Kunming II substation (Dongqiao extension)	12/31/88		12/89 <u>/a</u>
Qujing Substation	12/31/88		01/91 <u>/a</u>
(5) Training			

/a Rescheduled in accordance with the system's need to avoid early investment.

5. Project Results

A. Direct Benefits

Indicators	Appraisal estimate	Actual	
		1991	1992
1. Lubuge Power Plant			
Annual Generation (GWh)	2,750.0 (long-term average)	2,426.6	2,393.4
Capacity Factors	52.3%	46.1%	45.5%
Dependable Peaking Capacity (MW)	307.3	450.0	450.0
Peak Generation (MW)	600.0	638.0	627.0
Contribution to YPEPB System Energy Generation	27.8%	24.2%	21.2%
Peaking Capacity	20.2%	28.4%	25.7%
Equipment Efficiency (%)		1st unit	4th unit
Turbine	93.77/a	94.34	93.92
Generator	98.45/a	N.A.	98.51
2. Training			
Engineering and Design			
Construction Supervision and Construction			
Plant Operation and Maintenance			
Equipping of Technical Schools			
<u>Total</u>	5.0 million	2.38 million	<u>292</u> staff-months

n.a. = not available.

/a Contract specified.

COMMENTS:(1) 1992 was a very dry year, once in 100 years.

(2) The maximum output of 4 units all exceeded the rated capacity of 150 MW.

B. Economic Impact

	Appraisal Estimate	Actual
Economic Rate of Return (IERR)	12.0%	10.2%

- COMMENTS:** (1) The lower IERR is due primarily to increases in tariffs that were insufficient to cover the total operating expenses, including debt services.
- (2) No surplus benefit has been taken into consideration for its additional contributions as a master peaking plant of the Yunnan power grid.

C. Financial Impact

YPEPB's actual financial statements for 1984-92 and the related appraisal projections under Lubuge Hydroelectric Power Project are presented in Annex 3, Tables 1 to 4. The following table summarizes the key operational results forecast in the SAR for Lubuge Hydroelectric Power Project, compared with actuals.

YPEPB's Key Financial Indicators, 1984-92
(Million Yuan)

Year ended December 31	1984		1985		1986		1987		1988		1989		1990		1991		1992	
	SAR	Actual	SAR	Actual	SAR	Actual	SAR	Actual	SAR	Actual	SAR	Actual	SAR	Actual	SAR	Actual	SAR	Actual
Energy sales (GWh)	4,851	5,070	5,113	5,201	5,622	5,823	6,122	6,495	6,787	6,726	7,543	7,371	8,403	8,140	9,026	8,991		10,053
Average revenue (fen/kWh)	6.5	6.7	7.0	6.8	7.0	6.9	7.0	7.2	7.5	7.8	7.5	8.9	7.5	10.9	8.0	11.5		12.3
Break-even average tariff (fen/kWh)		6.8		6.8		7.9		7.9		9.1		11.7		13.0		13.7		14.5
Operating revenue	315	338	358	352	394	407	429	467	509	525	566	660	630	849	722	1,034		1,232
Operating expenses	212	232	231	274	263	327	295	396	336	466	382	546	438	686	473	805		1,025
Operating income	103	106	127	78	130	80	134	71	173	59	184	114	192	163	249	229		207
Net income before income tax & interest	104	105	127	77	130	75	134	65	173	57	184	109	192	151	249	215		190
Rate base	1,360	1,104	1,477	1,231	1,691	1,406	1,845	1,446	2,191	1,541	3,045	1,894	3,631	2,441	3,679	2,969		3,408
Annual capital expenditure	433		389	334	465	358	478	381	466	655	355	647	456	1,024	470	880		1,089
Construction work in progress	858		956	844	1,167	958	1,457	1,345	1,251	1,740	382	2,146	667	2,136	952	2,699		2,865
Fixed assets additions	52	48	291	311	225	144	187	66	652	396	1,225	465	171	760	185	661		156
Rate of return on hist. assets (%)	7.6	9.3	8.6	6.3	7.7	5.3	7.3	4.5	7.9	3.7	6.0	5.8	5.3	6.2	6.8	7.2		5.6
Operating ratio (%)	67	69	65	78	67	80	69	85	66	89	67	83	68	81	66	78		83
Self-financing ratio (%)				28.7		28.1		28.9		18.6		17.9		18.8		20.3		21.7
Debt service coverage (times)	30.0	8.5	35.0	9.5	11.8	1.4	7.0	1.2	5.7	0.8	3.2	0.5	2.2	0.6	1.9	0.7		0.7
Debt as % of debt plus equity	31	9	38	44	45	48	49	56	52	60	54	66	57	66	58	69		73
Average collection period (days)	49	13	44	41	43	25	42	28	37	29	36	29	34	34	32	29		21
Current ratio (times)	2.0	3.1	2.0	3.6	2.1	2.7	2.2	2.5	2.3	2.1	2.4	2.2	2.5	2.5	2.6	2.6		4.2
Debt service	5	10	5	8	16	59	29	74	43	118	87	275	143	381	205	429		506
of which: Principal	3	9	3	5	9	39	17	51	28	76	50	164	64	230	121	277		336
Interest	2	1	2	3	7	20	12	23	15	41	37	112	79	152	84	152		170

6. Project Costs and Financing

A. Comparison of Estimated and Actual Project Costs /a

Item	Appraisal estimate		Actual project costs /b					
	Y million	\$ million	Y million			\$ million		
			Local	Foreign	Total	Local	Foreign	Total
Land acquisition & resettlement	17.2	8.6	62.98	-	62.98	19.24	-	19.24
Main civil works	639.1	319.6	807.50	248.66	1056.16	274.02	72.28	346.30
Hydraulic equipment	18.7	9.3	22.85	-	22.85	6.53	-	79.58
Electrical & mechanical equipment	180.1	90.1	250.59	120.76	371.35	59.55	33.10	92.65
Transmission lines & substations	105.8	52.9	174.51	182.54	357.05	39.68	39.90	79.58
Consultant services	54.4	27.2	33.57	31.86	65.43	10.16	9.72	19.88
Training	10.0	5.0	1.85	6.92	8.77	0.54	1.84	2.38
Base Cost	1,025.3	512.7	1,353.85	590.74	1,944.59	409.72	156.84	566.56
Physical contingencies	71.6	35.8	-	-	-	-	-	-
Price contingencies	133.1	66.5	-	-	-	-	-	-
Total Project Cost	1,230.0	615.0	1,353.85	590.74	1,944.59	409.72	156.84	566.56

/a Not including IDC and other financial charges.

/b Each payment of foreign cost was converted to yuan and US dollars based on the prevailing exchange rates at the date of payment.

B. Project Financing
(\$ million equivalent)

Sources/items financed	Appraisal planned			Actual		
	Local	Foreign	Total	Local	Foreign	Total
<u>IBRD Loan</u>						
Civil works for water conductor system	-	35.4	35.4	-	35.7	35.7
Imported construction equipment	-	24.9	24.9	-	29.7	29.7
Imported construction material	-	26.8	26.8	-	20.3	20.3
Transmission lines & substation equipment	-	19.4	19.4	-	35.9	35.9
Electrical and mechanical equipment (other than turbines, generators, and auxiliaries)	-	17.6	17.6	-	18.2	18.2
Training	-	1.0	1.0	-	0.2	0.2
Consultant services	-	0.2	0.2	-	1.0	1.0
Front-end fee	-	0.4	0.4	-	0.4	0.4
Unallocated	-	19.7	19.7	-	-	-
Subtotal	=	<u>145.4</u>	<u>145.4</u>	=	<u>141.4</u>	<u>141.4</u>
<u>Norwegian Government Grant</u>						
Construction equipment and materials for underground powerhouse and tailrace tunnel	-	11.6	11.6	-	10.8/a	10.8
Consultant services for above works and training						
<u>Australian Development Assistance Bureau</u>						
Consultant services for dam, water conductor system and installation of generators	-	7.1	7.1	-	4.8/b	4.8
Training						
<u>Canadian International Development Agency</u>						
Consultant services for Special Board of Consultants	-	0.2	0.2	-	0.2	0.2
<u>Export/Supplier's Credit</u>						
Turbines, generators and auxiliaries /c	-	40.9	40.9	-	-	-
<u>People's Construction Bank of China</u>						
Local costs						
Foreign costs of turbines, generators and auxiliaries	364.8	45.0	409.8	409.3	-	409.3
<u>Technical Cooperation Credit</u>						
Consultant services for Special Board of Consultants	-	-	-	-	0.1	0.1
Total		<u>250.2</u>	<u>615.0</u>	<u>409.3</u>	<u>157.3</u>	<u>566.6</u>

/a NKr 88.0 million.

/b \$A 6.8 million.

/c Turbines, generators, and auxiliaries were supplied by a consortium of Kvaener of Norway and Siemens of Germany under a contract with the China National Technical Import Corporation (CNTIC). The foreign cost component was paid by CNTIC to the suppliers out of GOC's foreign exchange reserves.

7. Status of Covenants

Covenant	Subject	Status
Loan Agreement Dated March 12, 1984:		
3.01 (b)	Subsidiary Loan Agreement with YPEPB	Complied with.
Project Agreement Dated March 12, 1984:		
2.01 (b)	Maintain LPCMB with appropriate staffing and authority.	Complied with.
2.02	Employ Consultants.	Complied with.
2.08	Training Program.	Complied with.
3.04 (b)	Inspection of the Dam and Appurtenant Structures.	Complied with.
4.02	Annual Audit by Independent Auditors.	Complied with.
4.03 (a)	Gross revenue from all sources not less than YPEPB's total operating expenses.	YPEPB met 100% of the Bank loan payments, but made only partial payment of local loans.
4.04	Internal cash generation at least exceeds the debt service requirement.	Not complied with.
4.05	Future investment programs.	Complied with.

8. Use of Bank Resources

A. Staff Inputs
(Staff-weeks)

	FY81	FY82	FY83	FY84	FY85	FY86	FY87	FY88	FY89	FY90	FY91	FY92	FY93	Total
Preparation	1.7	70.7	9.3	-	-	-	-	-	-	-	-	-	-	81.7
Appraisal	-	-	54.9	-	-	-	-	-	-	-	-	-	-	54.9
Negotiations	-	-	19.5	55.8	-	-	-	-	-	-	-	-	-	75.3
Loan approval	-	4.2	7.7	8.4	-	-	-	-	-	-	-	-	-	20.3
Supervision	-	-	-	8.9	27.2	10.3	9.1	3.7	9.4	9.0	10.8	2.2	1.0	91.6
Other	-	-	-	2.2	0.5	0.1	0.2	-	-	-	-	-	-	3.1
Total	1.7	74.9	91.3	73.3	27.8	10.5	9.3	3.7	9.4	9.0	10.8	2.2	1.0	326.8

Note: FY93 data as of December 31, 1992.

B. Missions

Stage of project cycle	Month/year	No. of persons	Days in field	Specialization represented ^{/a}	Performance rating status ^{/b}	Types of problems
Preappraisal	04/05/82	3	30	a, c		
Appraisal	10/11/82	5	35	a, c, d		
Supervision I	08-09/84	2	31	a	1	
Supervision II	10-12/85	2	8	a, c	1	
Supervision III	08-09/86	2	9	a, c	1	
Supervision IV	06/87	1	7	a	1	
Supervision V	09/88	2	6	a, c	1	
Supervision VI	10/89	2	8	a, c	1	
Supervision VII	10/90	2	7	a, c	2	Not complied with loan covenants.
Completion	02/03/93	3	22	a, c		

^{/a} a = Engineer; b = Economist; c = Financial Analyst; d = Other.

^{/b} 1 = Problem-free or minor problems; 2 = Moderate problems; 3 = Major problems.

CHINA
LUBUGE HYDROELECTRIC PROJECT (LOAN 2382-CHA)

PROJECT COMPLETION REPORT

Overseas Training

Source of Financing	Subjects of Training	Location	Number of Groups	Staff-Months
Australian Grant	Engineering and Design Construction Management Modern Construction Technology Plant Operation and Maintenance	Australia Thailand Malaysia	14	123
Norwegian Grant	Engineering and Design Construction Management Construction Technology for Underground Works	Norway India	7	57
IBRD	Financial Management Network Management Computer Application Hydrological Forecasting	USA Australia Norway Japan	5	24
Taisei Corporation, Japan	Construction Management Construction Technology Accounting	Japan	3	30
Equipment Suppliers	Equipment Manufacturing and Inspection Operation and Maintenance Computer Application	Germany Norway Japan Sweden Switzerland	7	58
<u>Total</u>			<u>36</u>	<u>292</u>

CHINA

LUBUGE HYDROELECTRIC PROJECT (LOAN 2382-CHA)

PROJECT COMPLETION REPORT

Economic Reevaluation

Year	Capital costs		O&M costs (Y million)	Distri- bution & other costs	Total cost/ ^a	Annual gener- ation ----- (GWh)	Annual sales/ ^b -----	/ ^c Revenue per kWh (Y)	Total/ ^a revenue -- (Y million) ---	Net benefit	Constant price adjustment factor	
	Gener- ation	Trans- mission									Local	Foreign
1984	522.2	-	-	-	522.2	-	-	-	-	-522.2	1.728	1.192
1985	230.3	-	-	-	230.3	-	-	-	-	-230.3	1.588	1.152
1986	249.9	9.4	-	-	259.3	-	-	-	-	-259.3	1.498	1.130
1987	369.7	25.2	-	-	394.9	-	-	-	-	-393.9	1.369	1.090
1988	264.2	71.1	-	-	335.3	-	-	-	-	-335.3	1.178	1.048
1989	134.2	52.9	10.0	5.2	202.3	1,238	1,151	0.099	113.9	-88.4	1.000	1.000
1990	165.6	65.9	13.0	9.0	253.5	2,106	1,958	0.114	218.7	-34.8	0.980	0.949
1991	49.8	88.8	16.0	11.2	165.8	2,427	2,257	0.125	268.6	102.8	0.952	0.910
1992	47.2	42.0	19.5	15.5	124.2	2,393	2,226	0.133	258.0	133.8	0.872	0.873
1993	-	-	19.5	17.9	37.4	2,750	2,558	0.161	359.1	321.7	0.872	0.873
1994-2041	-	-	19.5	17.9	37.4	2,750	2,558	0.161	359.1	321.7	0.872	0.873

IERR = 10.2%

^a All costs and revenues were converted to 1989 constant prices by applying the adjustment factors based on price indexes for local and foreign costs.

^b A total loss of 7 percent was used, including station use and T&D losses (see Annex 6).

^c Revenue per kWh was based on YPEPB's current average tariffs, adding Y 0.01 per kWh surcharge for surplus benefits.

CHINA

LUBUGE HYDROELECTRIC POWER PROJECT (LOAN 2382-CHA)

PROJECT COMPLETION REPORT

Yunnan Provincial Electric Power Bureau

Income Statements, 1984-92
(Yuan Million)

	1984		1985		1986		1987		1988		1989		1990		1991		1992	
	SAK	Actual	SAK	Actual	SAK	Actual	SAK	Actual	SAK	Actual	SAK	Actual	SAK	Actual	SAK	Actual	SAK	Actual
Sales increase (%)	7.5	14.0	5.4	2.6	10.0	12.0	8.9	11.5	10.9	3.6	11.1	9.6	11.4	10.4	7.4	9.5	-	11.8
Energy sales (GWh)	4,851	5,070	5,113	5,201	5,622	5,823	6,122	6,495	6,787	6,726	7,343	7,371	8,403	8,140	9,026	8,991	-	10,053
Average revenue (fen/KWh)	6.5	6.7	7.0	6.8	7.0	6.9	7.0	7.2	7.5	7.8	7.5	8.9	7.5	10.4	8.0	11.5	-	12.3
Operating Revenue	315.0	338.0	358.0	351.6	396.0	407.0	429.0	467.4	502.0	524.5	566.0	660.0	680.0	849.0	722.0	1,034.2	-	1,231.5
Operating Costs																		
Fuel	54.0	57.7	59.0	61.8	67.0	77.8	80.0	100.8	95.0	118.6	96.0	145.8	95.0	163.8	102.0	154.8	-	261.1
Administration	3.0	5.2	3.0	6.5	5.0	17.3	5.0	21.7	5.0	23.6	6.0	26.7	6.0	30.0	8.0	35.6	-	57.8
Sales taxes	50.0	58.9	57.0	92.8	63.0	106.5	68.0	120.3	81.0	123.9	90.0	143.7	100.0	169.1	114.0	200.2	-	238.8
Depreciation	34.0	45.6	55.0	48.0	63.0	54.6	71.0	68.0	76.0	80.0	94.0	95.2	128.0	121.2	133.0	171.4	-	201.0
Other expenses	51.0	64.8	57.0	64.4	65.0	71.0	71.0	85.5	79.0	119.0	96.0	134.8	109.0	202.4	116.0	242.7	-	265.2
of which: Purchased power	-	12.6	-	8.2	-	8.4	-	7.8	-	35.8	-	36.8	-	58.9	-	51.3	-	28.8
Operation	-	30.6	-	33.5	-	36.4	-	48.6	-	50.8	-	54.2	-	68.6	-	82.7	-	102.8
Maintenance	-	21.6	-	22.7	-	26.2	-	28.0	-	31.2	-	37.3	-	66.3	-	97.6	-	113.9
Others	-	-	-	-	-	-	-	1.1	-	1.2	-	6.5	-	8.6	-	11.1	-	19.7
Total Operating Costs	212.0	232.2	231.0	273.5	263.0	327.2	295.0	396.3	336.0	465.1	382.0	546.2	438.0	686.5	473.0	804.7	-	1,024.7
Operating Income	103.0	105.8	127.0	78.0	130.0	80.0	134.0	71.0	173.0	59.2	184.0	113.8	192.0	162.6	249.0	229.4	-	206.9
Nonoperating income	-	-1.9	-	-0.8	-	-4.9	-	-5.7	-	-2.3	-	-4.6	-	-11.8	-	-14.5	-	-17.4
Interest charged to operation	2.0	1.0	2.0	3.3	7.0	19.6	12.0	23.1	15.0	41.3	37.0	111.5	79.0	151.7	64.0	152.0	-	169.9
Net Income Before Income Tax	102.0	102.9	125.0	73.9	123.0	55.5	122.0	42.2	158.0	15.6	147.0	-2.3	113.0	-0.9	165.0	62.9	-	19.6
Average Net Fixed Assets (Historic)	1,360.0	1,103.6	1,477.0	1,230.6	1,691.0	1,405.9	1,845.0	1,446.0	2,191.0	1,540.6	3,045.0	1,000.0	3,631.0	2,441.0	3,679.0	2,969.3	-	3,407.8
Rate of Return on Historic Assets (%)	7.6	9.4	8.6	6.3	7.7	5.3	7.3	4.5	7.9	3.7	6.0	5.8	5.3	6.2	6.8	7.2	-	5.6
Operating Ratio (%)	67	69	65	78	67	80	69	85	66	89	67	83	70	81	66	78	-	83

CHINA

LUBUGE HYDROELECTRIC POWER PROJECT (LOAN 2382-CHA)

PROJECT COMPLETION REPORT

Yunnan Provincial Electric Power Bureau

Balance Sheets, 1984-92
(Yuan Million)

	1984		1985		1986		1987		1988		1989		1990		1991		1992	
	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL
ASSETS																		
Current Assets																		
Cash	53	38	36	45	40	46	44	69	48	73	53	101	58	255	64	360	-	364
Inventories	30	33	31	38	32	45	33	44	34	50	35	69	36	81	38	88	-	88
Receivables	42	12	43	40	46	28	49	36	52	42	56	53	59	78	63	81	-	72
Total Current Assets	105	82	110	123	118	119	126	168	134	166	164	223	153	613	165	530	=	524
Fixed Assets																		
Plant in Service	1,976	1,621	2,267	1,929	2,522	2,066	2,709	2,123	3,361	2,511	4,586	2,965	4,757	3,732	4,942	4,360	-	6,032
(Less) Accumulated Depreciation	617	521	672	567	735	617	806	681	882	758	976	851	1,104	966	1,237	1,132	-	1,321
Net Plant in Service	1,359	1,100	1,595	1,362	1,787	1,449	1,903	1,443	2,479	1,753	3,610	2,114	3,653	2,765	3,705	3,228	=	4,711
Construction Work in Progress	858	-	956	844	1,167	958	1,457	1,345	1,251	1,740	382	2,146	667	2,136	952	2,699	-	2,065
Total Fixed Assets	2,217	1,100	2,551	2,206	2,954	2,407	3,360	2,787	3,730	3,493	3,992	4,260	4,320	4,902	4,657	5,928	=	7,576
Special Fund Assets	0	47	-	47	-	79	-	93	-	117	-	148	-	62	-	87	-	96
TOTAL ASSETS	2,322	1,229	2,661	2,375	3,072	2,605	3,486	3,028	3,864	3,775	4,136	4,632	4,473	5,377	4,822	6,544	=	8,196
LIABILITIES																		
Current Liabilities																		
Accounts Payable	-	-	-	52	-	54	-	55	-	57	-	59	-	60	-	62	-	64
Due to Government	-	20	-	34	0	33	-	44	-	61	-	82	-	127	-	186	-	103
Short-Term Debt	-	7	-	10	-	10	-	13	-	17	-	14	-	14	-	16	-	20
	-	-	-	-	-	-	-	-	-	-	-	4	-	5	-	4	-	2
Total Current Liabilities	52	27	54	36	55	42	57	58	59	78	60	99	62	168	64	203	=	125
Long-Term Liabilities																		
Long-Term Debt	690	51	982	943	1,329	1,067	1,668	336	1,967	639	2,181	946	2,485	1,482	2,730	1,810	-	3,006
Construction Loan	-	-	-	-	-	-	-	962	0	1,163	0	1,605	0	1,360	0	1,597	-	2,052
IBRD Loan	-	-	-	70	-	148	-	280	-	370	-	399	-	563	-	879	-	800
Total Long-Term Liabilities	690	51	982	1,013	1,329	1,214	1,668	1,578	1,967	2,172	2,181	2,950	2,485	3,405	2,730	4,287	=	5,858
Equity																		
Working Capital	-	33	-	33	-	40	-	47	-	49	-	52	-	48	-	52	-	64
Bilateral Grants	23	-	35	23	43	38	49	39	53	43	53	48	53	70	53	49	-	-
Government Fund	1,557	1,049	1,590	1,195	1,644	1,156	1,713	1,170	1,785	1,277	1,842	1,262	1,873	1,425	1,974	1,593	-	1,719
Special Funds	-	70	-	77	-	115	-	135	-	155	-	221	-	261	-	361	-	439
Total Equity	1,580	1,151	1,625	1,328	1,697	1,348	1,762	1,392	1,838	1,524	1,895	1,582	1,926	1,805	2,027	2,054	=	2,214
TOTAL LIABILITIES & EQUITY	2,322	1,229	2,661	2,375	3,071	2,605	3,487	3,028	3,864	3,775	4,136	4,631	4,473	5,377	4,821	6,544	=	8,196
Long-Term Debt as % of Debt & Equity	30.7	4.4	39.2	4.3	44.7	4.5	49.3	21.3	52.4	33.5	54.2	65.8	57.0	64.8	58.0	69.1	-	73.2
Current Ratio (times)	2.0	3.1	2.0	3.6	2.1	2.7	2.2	2.5	2.3	2.1	2.4	2.2	2.5	2.5	2.6	2.6	-	4.2

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CHINA

LUBUGE HYDROELECTRIC POWER PROJECT (LOAN 2382-CHA)

PROJECT COMPLETION REPORT

Yunnan Provincial Electric Power Bureau

Funds Flow Statements, 1984-92
(Yuan Million)

	1984		1985		1986		1987		1988		1989		1990		1991		1992	
	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL
Internal Sources of Funds																		
Net Income Before Income Tax & Interest	104.0	104.8	127.0	77.2	130.0	75.1	134.0	65.3	173.0	56.9	184.0	109.2	192.0	150.8	242.0	214.9	-	189.5
Depreciation	54.0	43.0	55.0	48.6	63.0	55.2	71.0	68.8	76.0	81.0	94.0	96.2	128.0	122.3	133.0	170.6	-	201.8
Maintenance Funds	-	-	-	22.9	-	26.4	-	28.3	-	31.6	-	37.6	-	66.6	-	98.2	-	113.9
Distribution Imprv Funds	-	-	-	-	-	15.0	-	-	-	14.7	-	16.9	-	19.6	-	15.3	-	35.0
Other Funds	-	32.0	-	34.1	-	80.3	-	-	-	96.7	-	132.5	-	284.8	-	380.1	-	426.9
Total Internal Funds	158.0	181.8	182.0	182.8	193.0	252.0	205.0	273.8	249.0	318.9	278.0	550.5	320.0	644.1	382.0	879.1	-	967.1
Borrowings																		
Proposed IBRD Loan	61.0	-	81.0	62.0	81.0	78.0	81.0	132.0	61.0	90.0	31.0	29.6	11.0	25.9	-	168.1	-	-
Other Loans-Project Related	170.0	-	113.0	105.3	148.0	119.1	202.0	20.4	180.0	131.9	68.0	288.4	19.0	365.6	4.0	95.5	-	-
Other Loans-Nonproj. Related	92.0	-	102.0	182.7	128.0	140.8	71.0	221.9	86.0	329.2	165.0	289.5	338.0	419.2	362.0	607.5	-	1,089.4
Total Borrowings	323.0	0.0	296.0	350.0	357.0	337.9	354.0	374.3	327.0	551.1	264.0	607.5	368.0	810.7	366.0	871.1	-	1,089.4
Government Contributions	65.0	-	63.0	4.8	70.0	21.0	78.0	4.7	75.0	100.1	76.0	35.7	88.0	143.4	80.0	-12.8	-	-
Bilateral Grants	22.0	-	12.0	-	8.0	-	6.0	1.3	5.0	4.1	4.2	70.1	-22.0	-	-	-	-	-
Total Sources of Funds	568.0	181.8	553.0	537.6	628.0	610.9	643.0	654.3	656.0	974.2	618.0	1,197.9	776.0	1,668.3	828.0	1,715.4	-	2,056.5
Capital Expenditures																		
Proposed Project	260.0	111.4	197.0	151.3	230.0	241.9	279.0	133.1	221.0	261.1	60.0	322.2	6.0	605.1	4.0	242.1	-	-
Other Construction	157.0	-	164.0	18.1	197.0	116.9	149.0	247.3	160.0	394.3	241.0	325.1	429.0	419.2	442.0	638.4	-	1089.4
Interest During Construction	-	16.0	-	29.4	-	38.0	-	50.0	-	65.0	-	55.0	-	21.0	-	24.0	-	-
Total Capital Expenditure	433.0	111.4	390.0	334.0	465.0	358.8	478.0	380.6	446.0	655.4	356.0	647.3	456.0	1,024.3	470.0	880.3	-	1,089.4
Operational Requirements																		
Inc/Dec in Working Capital	4.0	-6.0	3.0	20.8	7.0	9.1	6.0	-16.7	6.0	-9.5	9.0	0.7	7.0	-28.2	10.0	36.8	-	54.7
Inc/Dec in Special Funds Assets	-	3.0	-	0.9	-	17.8	-	14.0	-	24.1	-	31.8	-	-86.3	-	17.6	-	9.2
Interest Chgd to operations	2.0	1.0	2.0	3.3	7.0	19.6	12.0	23.1	15.0	41.3	37.0	111.5	79.0	151.7	84.0	152.0	-	169.9
Loan Repayment	3.0	-	3.0	4.7	9.0	39.0	17.0	50.3	28.0	76.3	50.0	163.9	64.0	229.7	121.0	277.2	-	335.6
Payment to Government	-	-	-	54.0	-	55.0	-	63.0	-	71.0	-	76.0	-	94.0	-	128.0	-	133.0
Depreciation	70.0	59.4	99.0	47.8	77.0	46.4	60.0	37.8	84.0	35.3	72.0	42.6	41.0	30.6	10.0	39.5	-	39.5
Special Funds Expenditures	-	6.0	-	118.3	-	120.0	-	141.8	-	146.3	-	172.4	-	193.1	-	206.6	-	354.0
Total Operational Requirements	133.0	63.4	162.0	195.8	163.0	251.9	166.0	250.3	209.0	314.2	262.0	522.9	319.0	490.6	358.0	729.7	-	962.9
Total Applications of Funds	566.0	174.8	552.0	529.8	628.0	610.7	644.0	631.1	655.0	969.6	618.0	1,170.2	775.0	1,514.9	828.0	1,610.2	-	2,052.3
Inc/Dec in Cash	3.0	7.0	3.0	7.8	4.0	0.2	4.0	23.2	4.0	4.6	5.0	27.7	5.0	153.4	6.0	103.2	-	4.2
Annual Debt Service Coverage	30.0	8.3	35.0	9.5	11.8	1.4	7.0	1.2	3.7	0.8	3.2	0.5	2.2	0.6	1.9	0.7	-	0.7

CHINA

LUBUGE HYDROELECTRIC POWER PROJECT (LOAN 2382-CHA)

PROJECT COMPLETION REPORT

Yunnan Provincial Electric Power Bureau

YPEPB's Key Financial Indicators, 1984-92
(Yuan Million)

	1984		1985		1986		1987		1988		1989		1990		1991		1992	
	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL	SAK	ACTUAL
Energy sales (GWh)	4,851	5,070	5,113	5,201	5,622	5,823	6,122	6,495	6,787	6,726	7,543	7,371	8,403	8,140	9,026	8,991	-	10,053
Average revenue (fen/kWh)	6.5	6.7	7.0	6.8	7.0	6.9	7.0	7.2	7.5	7.8	7.5	8.9	7.5	10.9	8.0	11.3	-	12.3
Break-even average tariff (fen/kWh)	-	6.8	-	6.8	-	7.9	-	7.9	-	9.1	-	11.7	-	13.0	-	13.7	-	14.5
Operating revenue	315	338	358	352	394	407	429	467	509	525	566	660	630	849	722	1,034	-	1,232
Operating expenses	212	232	231	274	263	327	295	396	336	466	382	546	438	686	473	805	-	1,023
Operating income	103	106	127	78	130	80	134	71	173	59	184	114	192	163	249	229	-	207
Net income before income tax and interest	104	105	127	77	130	75	134	65	173	57	184	109	192	151	249	215	-	190
Rate base	1,360	1,104	1,477	1,231	1,691	1,406	1,845	1,446	2,191	1,541	3,045	1,894	3,631	2,441	3,679	2,969	-	3,408
Annual capital expenditure	433	-	389	334	465	358	478	381	466	655	355	447	456	1,024	470	880	-	1,089
Construction work in progress	858	-	956	844	1,167	958	1,457	1,345	1,231	1,740	382	2,146	667	2,136	952	2,699	-	2,865
Fixed assets additions	52	48	291	311	225	144	187	66	652	396	1,223	465	171	760	185	661	-	156
Rate of return on historic assets (X)	7.6	9.3	8.6	6.3	7.7	5.3	7.3	4.5	7.9	3.7	6.0	5.8	5.3	6.2	6.8	7.2	-	3.6
Operating ratio (X)	67	69	65	78	67	80	69	85	66	89	67	83	68	81	66	79	-	83
Self-financing ratio (X)	-	-	-	28.7	-	28.1	-	28.9	-	18.6	-	17.9	-	18.8	-	20.3	-	21.7
Debt service coverage (times)	30.0	8.5	35.8	9.5	11.8	1.4	7.0	1.2	5.7	0.8	3.2	0.5	2.2	0.6	1.9	0.7	-	0.7
Debt as % of debt plus equity	31	9	38	44	45	48	49	36	52	60	54	66	57	66	58	69	-	73
Average collection period (days)	49	13	44	41	43	25	42	28	37	29	36	29	34	34	32	29	-	21
Current ratio (times)	2.0	3.1	2.0	3.6	2.1	2.7	2.2	2.5	2.3	2.1	2.4	2.2	2.5	2.3	2.6	2.6	-	4.2
Debt service	5	10	5	8	16	59	29	74	43	118	87	275	143	381	205	429	-	506
of which: Principal	3	9	3	5	9	39	17	31	28	76	50	164	64	230	121	277	-	336
Interest	2	1	2	3	7	20	12	23	15	41	37	112	79	152	84	152	-	170

CHINA

LUBUGE HYDROELECTRIC PROJECT (LOAN 2382-CHA)

PROJECT COMPLETION REPORT

YPEPB's Operation Performance, 1984-92

	Installed capacity		Generation		Energy sales (GWh)	Peak load (MW)	T&D losses (%)	Station use			Capacity factor	
	Total (MW)	Hydro	Total (GWh)	Hydro				Overall (%)	Thermal (%)	Hydro	Thermal (%)	Hydro
1984	1,169	679	5,410	2,660	5,070	888	7.07	6.2	11.7	0.25	59.1	44.7
1985	1,269	679	5,660	3,010	5,201	961	7.39	5.7	12.0	0.22	53.2	50.6
1986	1,369	679	6,360	3,320	5,823	1,004	5.94	5.8	11.9	0.20	50.3	55.8
1987	1,519	729	7,170	3,180	6,495	1,158	5.90	6.5	11.5	0.25	57.6	49.8
1988	1,769	879	7,530	2,610	6,726	1,226	5.73	7.7	11.6	0.38	63.1	33.9
1989	1,919	1,029	8,300	3,300	7,371	1,342	6.21	7.2	11.7	0.48	64.1	36.6
1990	2,169	1,179	9,080	4,550	8,140	1,520	7.04	6.0	11.7	0.41	52.2	44.1
1991	2,507	1,329	10,010	5,850	8,991	1,584	7.01	4.7	11.0	0.18	40.4	50.2
1992	2,607	1,329	11,280	5,510	10,053	1,749	6.71	5.5	10.3	0.19	51.5	47.3

Source: YPEPB.